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Integrated Pest Management Guide

Mountain Pine Beetle, *Dendroctonus ponderosae* Hopkins, in Ponderosa Pine, Kaibab Plateau, Arizona

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Introduction

The mountain pine beetle (MPB) is a native insect in ponderosa pine, *Pinus ponderosa* Laws., forests in northern Arizona, and several infestations have depleted stands on the Kaibab Plateau, Kaibab National Forest, and Grand Canyon National Park. Blackman (1931), using tree ring analysis and the presence of pitch pockets left by unsuccessful beetle attacks, reported the following outbreaks: 1837–1846, 1853–1864, 1878–1882, 1886–1892, 1906–1910, and 1916–1926. He studied the MPB on the Plateau in 1925 and 1926, and estimated that about 12 percent of the ponderosa pine type—totaling 300 million board feet of timber—was killed during the 1916 to 1926 outbreak. In an attempt to suppress the outbreak, thousands of trees were felled and peeled or felled and burned from 1922 to 1925; however, the evidence suggests that natural factors controlled the outbreak. Three localized and low-level outbreaks occurred from 1935 to 1978 on the Plateau. Elsewhere in Arizona and in New Mexico, the MPB has not caused significant tree losses.

The primary objective of this guide is to present biological information and management alternatives for the MPB on the Kaibab Plateau. Results of harvesting programs and studies done from 1975 to 1977 were used to develop alternatives. Also, information in publications, observations of pest management specialists, and unpublished information were used. It must be emphasized that techniques discussed in this guide are based on current knowledge and experience, and modifications will be needed as new information becomes available.

Life History and Habits

This insect completes one generation per year (Fig. 1). Adults begin attacking trees in early July and the attack period can extend i September. Sawtimber-size trees are preferred, but pole-size t are occasionally killed. Beetles attack trees by boring through the outer bark into the soft inner bark and then tunneling upward. Females lay eggs in individual niches on each side of the egg gallery. The gallery is packed with frass (bark particles, a small amount of wood particles, and some digested material). Small larvae hatch from eggs in 1 to 2 weeks and construct individual channels that are perpendicular to the egg gallery. Generally, they overwinter as small larvae. Larvae resume development the following spring and, when fully mature, excavate oval cells in which they transform into pupae and then adults. The adults bore their way out through the bark and attack new trees.

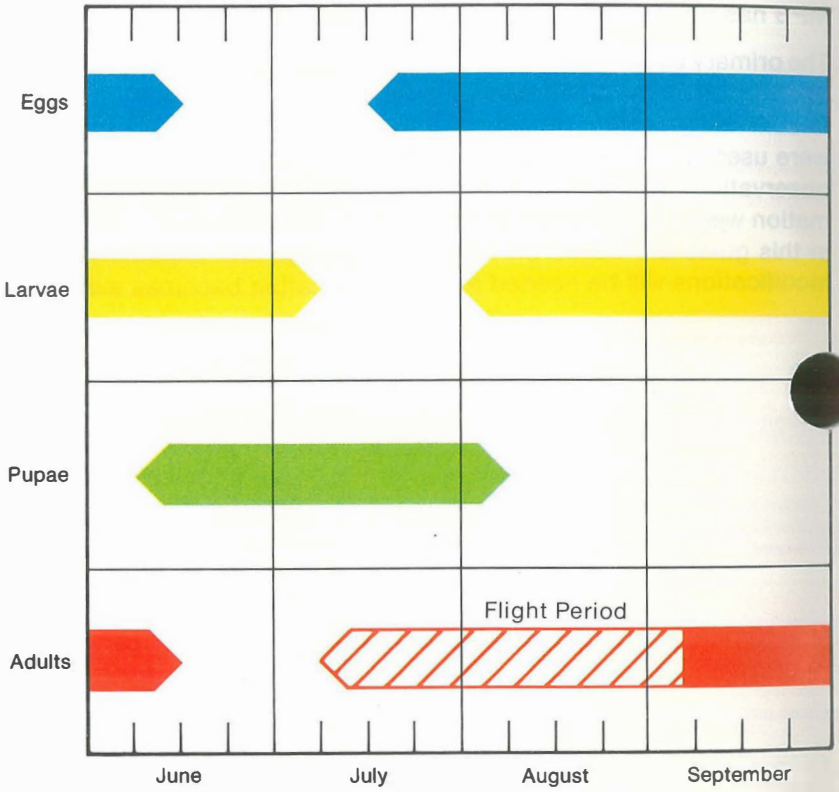

Figure 1. Seasonal distribution of stages.

Evidences of Infestation

Pitch Tubes

Pitch tubes on the trunk of live trees are the first sign of MPB attack (Fig. 2). They are dark reddish brown to tan masses of resin mixed with bark and wood which are about one-fourth to one-half inch (6 to 13 cm) in diameter. Larger cream-colored pitch tubes widely scattered over the bole indicate that beetle attacks were unsuccessful (Fig. 3).

Boring Dust

A second sign of attack is the presence of fine, light brown dust in bark crevices and around the tree base (Fig. 4). Trees must be closely examined to see this dust.

Gallery Pattern

Vertical, frass-packed egg galleries are constructed by females (Fig. 5). At the point of attack, the gallery curves to the left or right. Fully constructed galleries range from 6 to 30 inches (15 to 70 cm) long (McCambridge et al. 1979).

Blue-staining Fungi

Fungi, which are carried into trees by beetles, discolor the inner bark and eventually the sapwood. This discoloration is a certain sign that the trees have been successfully attacked by the MPB.

Stages of the Insect

Mountain pine beetles pass through the egg, larval, pupal, and adult stages each year. A description of each stage follows:

Eggs: Eggs are oval, pearl white, and are barely visible to the naked eye.

Larvae: The legless larvae (grubs) are white with brown heads. Mature larvae are about one-fourth inch (6 mm) long (Fig. 6).

Pupae: Pupae are white, slightly smaller than mature larvae (5 mm), and wing covers, legs, and antennae can be distinguished.

Adults: Beetles are about 3/16-inch (5 mm) long. New adults are light brown, but darken to black at maturity (Fig. 7).

Fading Trees

Trees attacked in August usually begin to fade in April and May. The needles change from green to yellowish green, and finally to yellowish brown (cover).

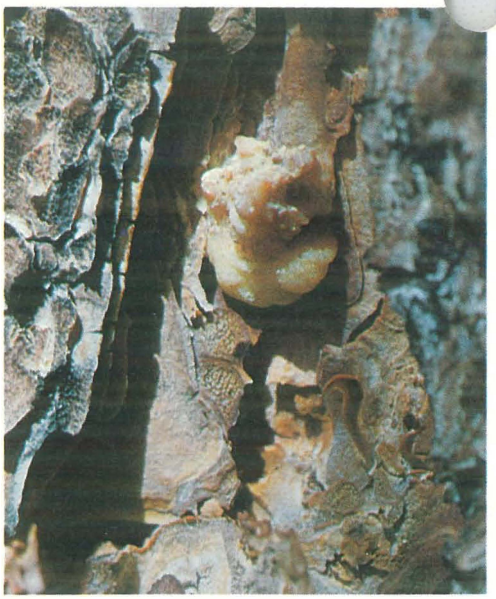

Figure 2. Pitch tube on successfully attacked tree.

Figure 3. Some trees pitch out attacking beetles and remain alive.

Figure 4. Frass at base of tree.

Figure 5. Egg galleries packed with frass.

Figure 6. Mature larvae under the bark.

Figure 7. Mature adult.

Management Alternatives

Prevention

Over 50 years, extensive harvesting in the ponderosa pine type and reduction of tree densities to 100 square feet basal area per acre or less, depending on site index, probably prevented MPB outbreaks. Blackman (1931) stated there was no known case of a large outbreak developing in a forest where continuous logging operations were done. Sartwell and Stevens (1975) indicated silvicultural thinning of second-growth ponderosa pine may reduce tree losses. Other factors must have been involved, however, since virgin ponderosa pine stands in Grand Canyon National Park incurred only minor tree losses due to MPB during the same period. Continued harvesting and reduction in tree densities on the forest is recommended for prevention, although further research or administrative studies are needed to assess the preventive effects.

Individual Tree Protection

High-value trees in campgrounds and near lodges and other buildings can be protected by applying a spray containing carbaryl to bark surfaces prior to beetle flight. Beetles attacking sprayed trees will be killed by the insecticide.

A water-base spray containing 2 percent carbaryl will protect a tree for at least one season. The spray must be applied to the point of runoff from the base of trees up to where the stem is about 5 inches (12.7 cm) in diameter. On large trees, the spray must be applied as high as possible, and at least above 30 feet (9.1 meters).

Mixing instructions for the Sevimol® 4 formulation of carbaryl follow: [1]

Small volumes—11 tablespoons (5.5 fluid ounces, 162.6 milliliters) of Sevimol per gallon of water.

Large volumes—17.5 quarts (16.6 liters) of Sevimol per 100 gallons (379 liters) of water.

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[1] The use of trade, firm, or corporation names on specific products in this guide is provided for information and convenience of the reader. This reference does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be available.

All insecticide containers carry a label that describes methods of use and required safety precautions. Be sure to read the entire label on the insecticide container and follow the directions. Also, established administrative requirements on pesticide use must be followed.

Suppression

Individual Tree Protection—Any technique that kills insects in infested trees achieves the same result—direct control. Fall and peel, fall and burn, and chemical treatment have all been tried for suppression. However, these approaches only succeeded in slowing outbreaks, not stopping them. The main difficulties with these approaches are that stand susceptibility is not changed and the timber resource is not utilized.

Sanitation-salvage logging is another approach that can be used to suppress low-level infestations. Outbreaks can be slowed by cutting, transporting, and milling infested trees. This approach can be used where valuable pine stands are threatened. At the same time, trees killed in previous years and nearby live trees that may be susceptible to attack can be harvested.

To be effective, infestations must be recognized before beetles begin to attack and kill trees in large groups. Once tree-killing reaches an average of about five trees per acre (12 trees per hectare), it may be too late to consider a suppression program without a substantial commitment of manpower and funds in a large-scale project.

The following steps must be done in the order presented for a sanitation-salvage program to be effective:

1. Detection. An infestation must be detected early to allow time to plan and execute a suppression program. All forest workers should be on the alert for beetle-infested trees when they are performing normal field activities, and report unusual situations. Occasionally, building outbreaks go unnoticed until they are detected during aerial surveys.

2. Biological evaluation. After infestations are detected, entomologists survey to determine the level of tree-killing, the relative abundance of the insect (ratio of new to old attacked trees), and the suspected susceptibility of the forest (stand structure in the infested area). Sampling is done in late September after the beetle flight is over. A biological evaluation report—summarizing survey results, management alternatives, and recommendations—is sent to the forest manager. The forest manager uses the information in this report,

along with other relevant information, to develop a management program.

3. Special documents. A decision to suppress an outbreak is made after thorough consideration of all pertinent aspects. Special documents that provide the decision base include:

a. Federal role statement (for Federal cost-sharing participation on non-Federal landownership).

b. Biological evaluation report.

c. Resource management plan.

d. Economic analysis.

e. Environmental assessment.

4. Presuppression survey. If the sanitation-salvage logging option is selected, a 100 percent examination of the infested area must be done as soon as possible to locate and mark currently infested, dead, and suspected susceptible trees (trees 12 inches in diameter and larger that are adjacent to groups of infested trees).

5. Logging. Removal of infested trees should begin after tree marking is well under way and the markers can keep ahead of the loggers.

To maintain suppression integrity, a trap-tree program can be done to attract beetles emerging from infested trees missed by markers and loggers. It has been found that markers and loggers miss about 10 percent of infested trees, even though they have received intensive training and close supervision. Párker and Stevens (1979) found that trap trees are attacked by beetles at about the same density as live trees; thus, the minimum number of trap trees that need to be cut can be determined by taking 10 percent of all trees marked. Susceptible, sawtimber–size trees should be cut in June and removed from the woods or destroyed in the fall. Trap trees can be cut along roads to maximize efficiency of removal, but they must be scattered over the project area. Broods in these trees will be destroyed when the logs are processed.

Salvage Logging

Another management alternative is to salvage beetle-killed trees and not attempt to suppress an outbreak. Accessibility of dead trees is a major factor in determining whether or not this approach would be

practical. Economic efficiency is another factor to be considered as part of the Forest Service planning/decision-making/NEPA process. In 1975, a comparison of salvage logging and sanitation-salvage logging for suppression was made to determine the most cost-effective approach to use in response to a low-level outbreak in three timber sale areas. The analysis showed that revenues for the salvage alternative would have been about $6,200 lower than logging for suppression benefits, but administrative costs for the suppression program would have been over four times higher: $54,600 versus $13,000 for the salvage program. The administrative costs for the suppression program would be high because all ponderosa pines in an infested area would have to be closely checked for evidences of beetle attack and infested trees marked during a presuppression survey. Conversely, it is relatively easy to locate dead trees with faded foliage for a salvage program. The benefit-cost ratios were 4.5:1 for the salvage logging program and 1.2:1 for sanitation-salvage.

Do Nothing

In some instances, the manager may decide to allow the outbreak to progress naturally. Tree losses may be accepted when (1) the costs of all alternatives outweigh benefits, (2) effective techniques are not available, (3) environmental effects of alternatives are unacceptable, or (4) alternatives conflict with other management objectives.

Integrated Pest Management (IPM)

Protection of forests from destructive agents is basic in the practice of forestry. IPM is a component of forest protection involving the use of a combination of cultural, biological, chemical, and other preventive and remedial measures to achieve effective, economical, and environmentally safe results. This approach has been and will be the preferred alternative for MPB on the forest, but a complete regime is not available for application. A principal problem in using an IPM approach is determining what specific measures are best for each management unit. A challenge for the future will be to further develop, evaluate, and initiate an IPM approach.

Summary

The MPB will continue to be an economically important pest in ponderosa pine stands on the Kaibab Plateau. On the forest, a combination of techniques can be used to protect stands. Silvicultural prescriptions should continue to include a provision to reduce tree densities to 100 square feet basal area per acre or less, depending on site index, to prevent outbreaks. High-value trees can be protected during outbreak periods by applying carbaryl to bark surfaces. Outbreaks can be suppressed in the early stages through sanitation-salvage logging in infested stands in conjunction with trap trees. It may be too late to protect valuable stands when outbreaks reach a high level without a large-scale suppression project, but beetle-killed trees can be salvaged.

On the Park, virgin stands are highly susceptible to this beetle and an outbreak will eventually occur. Protection of individual trees may be the only technique that can be used based on management policies for the area.

General information on the life history and habits, evidences of infestation, and management alternatives for the MPB is provided in this guide to serve as a reference tool. Additional information can be obtained from entomologists at: USDA Forest Service, Forest Pest Management, 517 Gold Avenue, SW, Albuquerque, New Mexico 87102; telephone – commercial (505) 766–2440, FTS 474–2440.

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